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ABSTRACT

This report reviews education programs and practices that have improved Native American student achievement in English language arts and mathematics. In Navajo tribal schools, teaching Indigenous language and literacy first, followed by teaching English and promoting bilingualism, helped students perform well on tests of vocabulary, comprehension, and writing. In Hawaii, a culturally congruent English language arts program significantly improved Native Hawaiian children's achievement in reading. Emphasis on comprehension over mechanics and phonics allowed children to learn in ways that were congruent with their everyday experiences outside of school. The use of ethnomathematics, based on the same principles of cultural congruence, led to improved student achievement for Native Hawaiian children and Alaskan rural middle school students. All these programs required extensive collaboration and time. Although limited in scope, the evidence suggests that congruency between the school environment and the culture of the community is critical to educational success. Collaborative research and development efforts, carried out at the local level, are needed. Seven action steps are recommended in this regard. An appendix outlines McREL's plan for further research. (Contains 31 references.) (TD)

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EFFECTIVE STANDARDS-BASED PRACTICES FOR NATIVE AMERICAN STUDENTS:

A REVIEW OF RESEARCH LITERATURE

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INTRODUCTION

One tenet of standards-based reform is that every student should have a quality education. A quality education is one that helps a student gain deep understanding of and ability to use important concepts, facts, skills, and habits of mind to improve his or her future (National Council of Teachers of Mathematics, 2000). To many Native American educators, developing and implementing content standards is a useful and positive process for improving education for Native American children (Alaska Native Knowledge Network, 1998; Fox, 2000). "Schools," however, "must see themselves as accountable for providing the educational program and support necessary for Indian students to meet the standards" (Fox, 2000, p. 9).

To better understand the qualities of education programs and support necessary for Native American students to reach standards, researchers and technical assistance providers at Mid-continent Research for Education and Learning (McREL) have reviewed research and related literature and are conducting field studies. In this report, we synthesize research and related literature produced primarily, but not exclusively, by Native American scholars and educators. Our purpose is to establish access to Native American research by recognizing the educational innovations developed by Native American people, their purposes and outcomes, and lessons learned and to propose a plan of research services that will benefit Native Americans in the seven-state Central Region served by the regional education laboratory at McREL. This report is written for educators, researchers, and policymakers working to improve educational opportunities and outcomes for children. In accordance with our obligations as a regional education laboratory, this line of inquiry aims to generate and utilize evidence about how to transform low-performing schools into high-performing learning communities for Native American students. Our focus is on improving Native American students' learning in reading and mathematics. Our sources of information are previous research reviews, and case study and program evaluation reports on innovative programs as identified in searches of the ERIC database and adjunct clearinghouses.[1] Additionally, we reviewed research reports identified in the references of the initial set of reports.

We originally planned to synthesize evidence about effective classroom practices for teachers of Native American students. We expected to provide guidance that was well grounded in results of

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[1] We searched publications between 1970 and 2002 at http://ericir.syr.edu/Eric/adv_search.shtml and http://www.indianeduresearch.net/ with the following keywords: instructional practices, effective instruction, teaching practices, learning styles, cultural compatibility, Native American students, American Indian students.

research systematically linking classroom practices to academic learning. What we primarily found, however, were descriptions of curricula and very few reports on students' academic achievement when the curricula were implemented. We did find case study and evaluation reports that included academic achievement results in association with multi-year, multi-component program innovations. These innovations were implemented and evaluated in schools serving Native American students. For the most part, the studies were conducted under naturalistic conditions with little control over student variables prior to the innovation or systematic recording of the implementation procedures or conditions. Nonetheless, we draw our conclusions on the best evidence available, acknowledge limitations, and make recommendations when appropriate.

The content of this report is organized into two sections. Native American research and related literature on education practices and outcomes in English language arts are reviewed, followed by a review of Native American research and related literature on education practices and outcomes in mathematics. Each of the sections also includes a summary of procedural knowledge gained from reform projects that explicated and connected Indigenous and Eurocentric knowledge to develop and align curriculum and assessment. This report concludes with recommendations for research and development steps that should benefit Native American clients in McREL's region.

English Language Arts

Research and evaluation findings support the effectiveness of two types of programs for developing Native American student literacy in English. One type of program teaches literacy in a community's Indigenous language first, then promotes bilingualism by maintaining that language while teaching English language and literacy. Evidence supporting this type of program primarily comes from demonstration projects in Navajo community-controlled schools. The second effective program creates cultural congruence for Native American students in school, but not necessarily bilingualism. Evidence supporting this approach primarily comes from evaluations of an elementary school program designed for Polynesian-Hawaiian children.

Indigenous Language and Literacy First, Bilingualism Second. Federal policymakers supported the role of school in developing Indigenous language and literacy prior to World War II. John Collier, named Indian Affairs Commissioner in 1933, supported bilingual education for Native American students, initiated a retraining program for teachers to become knowledgeable and more sensitive to Native cultures, and closed some boarding schools, replacing them with day schools (Reyhner, 1992). Collier also assisted in the development of the Johnson O'Malley Act in 1934, which was amended in 1975 as the Indian Self-Determination and Educational Assistance Act (P.L. 93-638). Although cut short by World War II, Bureau of Indian Affairs (BIA) personnel in the 1940s worked with Native language speakers to develop bilingual programs and reading texts written in Indigenous languages for American Indian students (Lomawaima & McCarty, 2002).

It was not until the 1960s that federal policymakers again recognized the value of bilingual/bicultural curriculum and materials for Native American students. In the late 1960s, Rough Rock Demonstration School emerged as a tribally run, community-oriented school in the center of the Navajo Reservation in northeastern Arizona several hours drive from the nearest towns on the border of the reservation (McCarty, 1989). The Rough Rock education program was designed to expose children to important values and customs of both Navajo culture and the dominant society. The school used "an innovative English-as-a-second-language program, Navajo language and social living classes, cultural presentations by community members, and the development of textbooks on Navajo life" (McCarty, 1989, p. 489). Both Navajo and English were used as languages of instruction (Holm & Holm, 1995).

The school's heralded outcomes in the late 1960s were not about academic success, but rather, about improved economic vitality, Navajo pride, and self-governance in the community. School jobs at Rough Rock doubled the local per-capita income. School board members acquired leadership and administrative skills for operating federal programs, which led to new facilities and roads, opening the door to the wider community (McCarty, 1989). McCarty (1989) reports the sequence of changes that occurred in response to Rough Rock's demonstration:

> In 1968, Senator Robert Kennedy, then Chairman of the Special Senate Subcommittee on Indian Education, declared that "Rough Rock has proven its point . . . and should serve as a model for all Indian schools to study and emulate." He also called for a "bold new statement of policy coupled with the commitment and resources necessary to carry it out." Those resources followed in 1972 and 1975 when Congress passed, respectively, the Indian Education Act (adopted as Title IV amendment to the Elementary and Secondary Education Act), and the Indian Self-Determination and Educational Assistance Act. The legislation provided funds for bilingual-bicultural and adult education, and formalized the procedure for tribes and Indian communities to contract directly with the federal government for education monies. By 1976, six Indian communities had followed Rough Rock in contracting with the Bureau to run their own schools, several tribes had community-controlled colleges, and hundreds of public schools across the country had Title IV funds for Indian education. (p. 492)

The story of the school's education program, however, is more modest. According to McCarty (1993), the bilingual/bicultural program at Rough Rock was difficult to sustain because of inconsistent federal funding and unstable and insufficient numbers of bilingual staff and curricula materials. Seeking stability in the early 1980s and an increase in student scores on norm-referenced tests, the Rough Rock school board adopted a commercial English basic skills program involving teacher-directed instruction (McCarty, 1993). During the period of its use, staff and parents observed that the students had "near-perfect English diction, but with little

comprehension of oral English or text" (McCarty, 1993, p. 183). To move to a greater emphasis on comprehension, in 1987 Rough Rock partnered with the Kamehameha Early Education Program (KEEP). KEEP is an English language arts program (described in more detail in the next section) that emphasizes language and cognitive development through culturally congruent curriculum and activities and emphasizes comprehension rather than mechanics or phonics. In addition to the KEEP approach, teacher-researcher teams at Rough Rock developed and used thematic units and other curricula in Navajo. Classroom teachers also implemented "contextualized reading, process writing, cooperative learning centers, language experience activities, and questioning designed to encourage critical thinking (McCarty, 1993, p. 184). Three years later, between spring 1990 and spring 1991, K–3 students' percentile scores in reading vocabulary on the California Test of Basic Skills "more than doubled," though they were still below the national norm (McCarty, 1993).

Two schools that like Rough Rock, are tribally run, are Rock Point Community School and Fort Defiance Elementary School, both also serving Navajo communities in Arizona. In 1971, Rock Point Community School became a tribally controlled school and received Title VII Indian bilingual funds to implement a Navajo-English bilingual program. Students learned to read and write first in Navajo; in second grade, students began learning to read and write in English. Thereafter, students read and wrote in both languages. In each primary classroom, two teachers, a Navajo Language Teacher and an English Language Teacher, worked simultaneously at either end of the classroom. Holm and Holm (1995) reported that the students alternated between working with the two teachers and engaging in independent work. At first, the faculty included both degreed and non-degreed teachers. Over time, through collaboration with a regional university providing on-site and off-site courses and practicum experience, about 50 educators and community members earned their degrees.

Across the three core content areas of language arts, mathematics, and social studies (science was added later), instructional practices emphasized language and thought — "students were expected to show they knew what they were doing" (Holm & Holm, 1995, p. 147). The program also included curriculum-specific, criterion-referenced tests, high expectations, and coaching.

Results of program evaluation conducted at Rock Point Community School supported the effectiveness of the Navajo-literacy-first instruction. Rosier and Farella (1976) compared English reading comprehension of the fourth- and fifth-grade students who participated in this program with national average achievement levels. For the Rock Point students, the typical one-and-one-half-year gap in performance between Native Americans and the national average was reduced to one-half year in association with Navajo-literacy-first instruction. Moreover, rate of growth in English reading achievement for students at Rough Rock Community School was faster over the three years between second and fifth grade than that for students attending non-tribally controlled Bureau of Indian Affairs schools (Rosier & Farella, 1976). Finally, close to 50 percent of the fifth-grade group who received the Navajo-literacy-first instruction scored at or above a grade

equivalent of 5.5 (Rosier & Farella, 1976). Prior to the program's implementation, no fifth-grade group averaged at or above a grade equivalent of 5.0.

At Fort Defiance Elementary School, kindergarten and first-grade instruction was almost entirely in Navajo, with 40 minutes a day of small-group instruction in English. In second and third grades, students began learning to read and write in English; half the day's instruction was in Navajo, half was in English. Thereafter, students read and wrote in both languages and mathematics was taught in both languages. Similar to the Rock Point curriculum, the Fort Defiance curriculum emphasized language and thinking. In addition, "process writing and cooperative learning approaches were extensively used" (Holm & Holm, 1995, p. 150).

Academic results at Fort Defiance Elementary School showed that although students participating in the Navajo-literacy-first instruction performed as well on English language tests as Navajo students taught in English, their performance on English reading tests was slightly behind. According to Holm and Holm (1995), however, the Navajo-literacy-first instruction students performed far above the English-only students on standardized tests of mathematics and on local assessments of writing-in-English.

Although not replicated at Fort Defiance Elementary School, the Navajo students' English literacy achievements documented at Rock Point Community School are consistent with other research findings confirming the facilitative role of becoming initially literate in one's first language before learning to read and write in a second language (Calderón, Hertz-Lazarowitz, & Slavin, 1998; Saunders, 2001).

The conditions necessary for successful implementation of an elementary school program that teaches Native language and literacy first supports maintenance of this language, and teaches English language and literacy include (1) a bilingual faculty with low turnover and ample, high-quality learning opportunities, and (2) sufficient learning materials aligned with the sequence of content and skills emphasized in the bilingual curriculum assessed by the accountability measures. At both Rough Rock Demonstration School and Rock Point Community School, ten or more years was needed to create these conditions (Holm & Holm, 1995; McCarty, 1989; McLaughlin, 1995). Moreover, the conditions were created by collaborative efforts between community leaders and university faculty in nearby teacher preparation programs, and the ongoing, time-consuming efforts of successful grant-writing administrators (Holm & Holm, 1995; McCarty, 1989; McLaughlin, 1995). Often, McCarty (1989) observed, the efforts required to secure school funding diverted attention and energy away from improving the pedagogical program and caused discord between board members as they became invested in a multitude of different initiatives.

This section reviewed empirical evidence for the effectiveness of primary grade programs emphasizing Indigenous language and literacy first, then English and bilingualism. The evidence

is mixed and limited. On the one hand, achievement outcomes showed growth in reading vocabulary and achievement of grade-level competencies in reading comprehension (McCarty, 1993; Rosier & Farella, 1976). On the other hand, at another site, reading performance was slightly lower for program students compared to non-program students, but local writing assessments showed greater achievement for program students (Holm & Holm, 1995). We also noted that the effectiveness of transitional bilingual programs, such as the ones implemented at the Navajo community schools, has been confirmed in schools serving Latino students (Calderón, Hertz-Lazarowitz, & Slavin, 1998; Saunders, 2001). Yet, in all these studies, the English Language Learners comprised a large majority of the schools' student population. The relevance of these examples to schools serving populations with low percentages of Native American students, or students with other culturally and linguistically different backgrounds, is limited.

Culturally Congruent English Language Arts. Demmert's (2001) review of research concludes that cultural congruence between Native American students' home and schooling improves academic achievement. He bases this conclusion on the positive outcomes of four demonstration projects for native students in Arizona, Hawaii, and New Zealand. In reports (e.g., Stiles, 1997), outcome measures did not include academic achievement; instead, measures indicated increased attendance, reduced dropout rates, increased community pride, and strengthened sense of identity. The Hawaiian project, however, measured academic achievement.

Cultural congruence, not bilingualism, characterizes the Kamehameha Early Education Program (KEEP) in Hawaii (Jordan, 1984). KEEP was developed in Honolulu in the early 1970s with the goal of improving achievement levels of low-income and at-risk Native Hawaiian students in grades kindergarten through three. As an English language arts program, KEEP includes a behavior management component that creates a social organization and peer interaction styles that are similar to Native Hawaiian sibling and companion group interactions at home. Four other features also distinguish KEEP: (1) a comprehension-oriented approach to reading instruction instead of emphasis on mechanics or phonics, (2) an emphasis on language and cognitive development, (3) use of individualized instruction with continuous monitoring of progress, and (4) a quality control system for teacher performance.

KEEP classrooms are organized around learning centers in which high rates of peer interaction and help occur and satisfactory task performance per individual is expected. In addition, children in KEEP classrooms are divided into five or six reading groups, according to level of reading competence, that meet daily with the teacher. Each child attends five centers each day, one of which is always focused on the reading group lesson (Jordan, 1984). Moreover, during reading group sessions, teachers spend as much time as possible interacting with and coaching the members of the group. Classroom norms also are established so that other children do not interrupt the teacher working with the reading group.

Tharp (1982) conducted two studies on the effectiveness of KEEP; one was conducted in a laboratory school, and the other in a sample of four public schools. After two years of implementation in the laboratory school, results supported the effectiveness of KEEP. Average standardized test scores in reading comprehension for children participating in KEEP were close to or above the 50th percentile compared to an average at the 23rd percentile or below for children in non-KEEP classrooms. When KEEP was implemented in 19 other classrooms spanning four public schools (serving mostly Native Hawaiian students in an urban locale), average scores on the Gates-Machinate and Metropolitan standardized reading tests were at the 53rd percentile, while the average scores for children in comparison classes were at the 32nd percentile (Tharp, 1982). Children were not randomly assigned to type of classroom or school, but all participating schools were in the same locale, "an economically depressed belt of the city" (Tharp, 1982, p. 511). Moreover, systematic observations of KEEP and comparison classrooms showed clear differences in the instructional practices. During the English language arts period, teachers in KEEP classrooms spent 66 percent of the time teaching comprehension, while teachers in comparison classrooms spent only 30 percent of the time on comprehension. KEEP teachers also used criterion-referenced tests more frequently to monitor students' progress and used small-group arrangements more often.

In the 1980s, KEEP program developers also worked with teachers at the Navajo Rough Rock Demonstration School in Arizona. Modeling KEEP practices in the classroom, and observing and listening to the children, program developers helped Rough Rock teachers incorporate learning experiences that were culturally compatible with their Navajo students. The third-grade children, for example "clearly preferred — and often demanded — to hear or read a story through to the end before starting discussion, rather than discussing it in piecemeal successive sections" (Tharp & Yamauchi, 1994, p. 7). Evidence on the effectiveness of these experiences for developing children's reading comprehension, however, was not available.

With respect to written expression, our review identified culturally specific thinking patterns and discourse norms for Native American students, but found little evidence on the effectiveness of approaches that accommodated or built on these strengths. According to Sawyer's (1988) review of reports written by teachers of Native American students, descriptive and narrative writing, for example, is easier for Native American students whose language tradition is oral. Unfamiliar to many Native American students, especially if accustomed to circular story grammars, may be the linear thesis-support-summary structure typical of the five-sentence paragraph and five-paragraph essay. "Most difficult for Indian students," Sawyer (1988) suggests, "is comparison and argumentation because of a more harmonious sense of order that views certain Western cognitive processes (e.g., cause and effect, comparison/contrast, Aristotelian logic) as unnecessarily complicated and even untruthful" (p. 19).

Sawyer (1988) emphasizes the importance of student motivation in learning how to write effectively. He advocates for, as do St. Charles and Costantino (2000), holistic approaches to

writing instruction for Native American students. Holistic approaches combine listening, speaking, reading, and writing and embed grammar lessons in the context of writing as a means of communicating something personal and vital, usually through the process of revision rather than as a prerequisite to writing. Use of authentic language and literature and embedded skills instruction are practices consistent with recommendations for improving language arts skills of Native American students (Fox, 2000). However, we found no empirical evidence on the effectiveness of these approaches for developing Native American students' writing.

An alternative approach, and perhaps one that would complement the holistic, personalized approach advocated by Sawyer (1988) and Fox (2000), is to teach directly, and scaffold students' use of, the skills and strategies needed to successfully write in ways required for school success. Wilcox (1996) provides limited evidence that such explicit instruction on strategies may be effective for Native American students. Wilcox (1996) conducted case studies on the use of TOWER + EDITS with two Native American students, one in seventh grade and one in ninth grade, both attending the Winnebago Public Schools in Nebraska. TOWER + EDITS is an acronym for Think, Organize, Write, Edit, and Rewrite combined with teacher-assisted EDITS (i.e., Embellish, Delete errors, Insert corrections, Tally progress, and Submit for grading). The acronym and sequence of strategies it stands for help students visualize and monitor their writing process.

Wilcox (1996) analyzed the students' writing samples from before and after TOWER + EDITS instruction for the number of words, number of sentences, length of sentence, and vocabulary grade level. The first student showed an increase in the number of words per essay, the number of sentences, and the length of sentences. Vocabulary use remained at the fifth/sixth-grade level. The second student did not have a pre-intervention writing sample; however, over five months, the student moved from refusing to write anything to writing essays that exceeded 300 words.

To summarize, one program of research and development, the Kamehameha Early Education Program (KEEP), provided evidence of the effectiveness of culturally congruent English language arts instruction for Native Hawaiian students (Tharp, 1982). Findings were replicated across two types of settings (laboratory school and public schools). In the public schools, economic conditions were comparable and there were documented differences in instructional practices between KEEP classrooms and non-KEEP classrooms. These findings and study design features lend confidence to the conclusion that cultural congruence, rather than extraneous variables, contributed to the higher reading achievement of the Native Hawaiian students.

The effectiveness of bilingual/bicultural programs, culturally congruent instruction, and explicit instruction on strategies in English language arts for Native American students is supported by a small amount of empirical evidence. Case studies of Navajo demonstration schools in Arizona, single-subject research in Nebraska, and program evaluation of KEEP in Hawaii show that these practices can be effective for improving Native American students' reading and writing

performance (Holm & Holm, 1995; McCarty, 1989; Rosier & Farella, 1976; Tharp, 1982; Wilcox, 1996). This evidence is particularly limited by type of school population and locale. The majority of Native American students do not attend tribally controlled schools, but, rather, attend public schools where they are in the minority (U. S. Department of Education & U. S. Department of the Interior, 2001). In response to the limitations of existing evidence, the *American and Alaska Native Education Research Agenda* (U.S. Department of Education & U. S. Department of the Interior, 2001) calls for large-scale, multi-site research on the education experiences and outcomes of Native American students. A priority research topic is the level of Native American and Alaskan Native student achievement on standardized assessments by type of school and grade (U. S. Department of Education & U. S. Department of the Interior, 2001).

MATHEMATICS

In mathematics, *ethnomathematics* is the recommended approach for connecting home and school and promoting academic success in classrooms and schools with culturally diverse groups of students. Although the principles of *ethnomathematics* are well articulated, and numerous curricular projects have been developed that are aligned with the *NCTM Principles and Standards* (NCTM, 2000), research on the effectiveness of *ethnomathematics* for Native American students is limited.

Ethnomathematics is the study of traditional and everyday mathematics and the integration of findings from this study into the development and use of curricular methods and materials that are aligned with content standards (Brenner, 1998; Davidson, 1989). *Ethnomathematics* "acknowledges the value of the knowledge base that children themselves bring to school" and engages children in activities based on everyday mathematics in ways that help them "develop meaningful problem solving and greater mathematical power" (Brenner, 1998, p. 239).

Brenner's (1998) multi-year research and development in *ethnomathematics* led to several changes in a kindergarten and second-grade math program in the KEEP laboratory school in Hawaii. For one or two years, Brenner (1998) conducted ethnographic and cognitive research to learn about children's everyday mathematics. She interviewed, observed, and assessed Native Hawaiian children attending the KEEP school during both in-school and after-school settings. Based on her findings, Brenner and KEEP teachers (1) altered the sequence of topics and textbook chapters to match what children had demonstrated was easier or more difficult to learn, (2) incorporated Hawaiian Creole English terms for some mathematics concepts into instruction, (3) added manipulatives to students' independent work (e.g., block counting), and (4) added a game center with mathematical content to the classrooms. Compared to a control group, the children participating in the kindergarten classroom in which these changes took place scored significantly higher on a standardized math test. The control class averaged at the 54th percentile, while the experimental class averaged at the 82nd percentile (Brenner, 1998). Moreover, children

in the classroom using the alternate sequence of topics and textbook chapters progressed faster through workbook exercises that children in the control classroom.

Brenner's (1998) experiences also revealed how use of everyday mathematics activities in the classroom can detract from developing children's greater mathematical power. In a second grade classroom, where a school store was established to engage students in purchasing and selling, Brenner (1998) observed a lot of contrived tasks and mundane work running the store, such as counting the inventory, that were not mathematically challenging. These observations are consistent with warnings that *ethnomathematics* must avoid trivial cultural connections (Dukepoo, 1993, as cited in Nelson-Barber & Estrin, 1995). To help students develop deeper understanding and move from concrete and semi-concrete levels to more abstract mathematics, Davidson (1989) suggests use of systematic language activities, such as having students describe and explain their procedures and solutions, and create and solve story problems in writing.

On a large scale, the work of the Alaska Rural Systemic Initiative (RSI), supported by National Science Foundation (NSF) grants, demonstrates application of the principles and practices of *ethnomathematics* to the reform of mathematics and science in rural schools. Focusing on mathematics and science, the Alaska RSI is a set of initiatives whose purpose is to study and document "the indigenous knowledge systems of Alaskan Native people and develop pedagogical practices that appropriately incorporate indigenous knowledge and ways of knowing into educational programs" (AKRSI, *Year Three Report,* n.d.b, p. 1). One component of the Alaska RSI is Elders and Cultural Camps, based on Kawagley's (1999) model of Alaskan Native camps.

The purpose of the Alaska RSI is to implement a set of initiatives to systematically document the indigenous knowledge systems of Alaska Native people and develop pedagogical practices that appropriately incorporate indigenous knowledge and ways of knowing into educational programs

For Kawagley (1999), content standards should specify Indigenous knowledge and Eurocentric knowledge as complementary rather than competing learning goals.

> It is absolutely necessary that students learn Eurocentric concepts as well as their own ways of recognizing patterns, symbols, estimation/intuitive measurement, and ways of keen observation of place. Native students have to realize that our ways of measuring and knowing are identity-building processes, and that in-depth knowledge of these ways need not interfere with one's being and connection to the earth. Native students can then pursue careers in mathematics and the sciences buttressed by a Nature-way worldview giving them a kind and polite disposition to the world. (p. 49)

Kawagley (1999) proposes that learning activities in Alaskan Native camps be planned so traditional and Eurocentric mathematics and science are compatible with one another. Content for the camps should be selected judiciously, and students should evaluate its utility. He proposes

three types of camps: Language Development Camp, Immersion Camp, and Bridging Camp. At Bridging Camp, for example, Yupiaq knowledge is taught by elders and augmented with useful Eurocentric science and mathematics. The following practices are used at Bridging Camp:

- Traditional estimation/intuitive measurement is used; recognition of patterns and symmetry is stressed (without mathematical equations to confuse the issue — the universe is not all numbers).
- The most useful Eurocentric scientific terms are determined and Native words for those terms are coined with help form elders and students.
- In using the Eurocentric science knowledge and theories, students determine whether that knowledge will add to or detract from one's Native identity.
- Youth determine whether Eurocentric knowledge is useful and applicable locally; or whether it is just show and tell/extraneous knowledge. (Kawagley, 1999, p. 48)

Although evidence was not found on the impact of student learning when these particular practices have been implemented, the Alaska RSI evaluation results offer some evidence for the effectiveness of a similar camp. After participating in a regional science camp that exposed students to knowledge embedded in many traditional activities of the local Native people, middle school students showed a significant gain over their previous year's academic performance and over the performance of a control group of students who did not attend camp (AKRSI, *Year Four Report*, n.d.b). Similarly, in a Montana school district serving a population with 49 percent of the students from the Crow tribe, Zwick and Miller (1996) found that culturally relevant, field-based science activities in a nearby wildlife preserve were effective for improving fourth-grade student achievement.

Overall, the Alaska RSI outcomes are positive. Dropout rates have declined in Alaska RSI partner schools and the percentage of eighth-grade students scoring in the top quartile on standardized achievement tests in mathematics increased in Alaska RSI Partner schools, while the percentage stayed the same in non-Alaska RSI Partner schools during 1996 and 1997 (AKRSI, n.d.a). The Alaska RSI evaluators concluded that "the cumulative effect of increasing the connections between what students experience in school and what they experience outside school appears to have a significant impact on their academic performance" (AKRSI, *Year Three Report*, n.d.b, p. 3).

The conditions necessary for successful implementation of the principles and practices of *ethnomathematics* include time and resources to (1) identify culturally specific and everyday knowledge, (2) develop and field-test responsive curricular materials and learning activities, and (3) use formative evaluation to make adaptations and revisions. In both Brenner's (1998) project

and the Alaska RSI, collaborative working relationships between researchers, community members, and teachers allowed access to elders and families for the study of culturally specific and everyday knowledge, and development of methods, materials, and programs that were aligned with both this knowledge and content standards from the more formal school curricula. In conclusion, the research and evaluation findings in mathematics education for Native American students suggest that curricula and practices that acknowledge and build on traditional and everyday mathematics are effective for improving students' academic success. The evidence reviewed here, however, is limited to studies from only three sites, kindergarten and second-grade classrooms in Hawaii, a network of rural schools in Alaska, and two fourth-grade classrooms in one district in Montana. More research is needed to find, generate, and disseminate knowledge gained from studies in schools in a variety of locales and jurisdictions.

SUMMARY AND CONCLUSIONS

This report reviewed evidence on the effectiveness of different education programs and practices for improving Native American student achievement in English language arts and mathematics. Case study and program evaluation reports indicate that in tribally controlled schools serving Navajo communities, teaching Indigenous language and literacy first, followed by teaching students to read and write in English and promoting bilingualism, helps students perform well on norm-referenced tests of reading vocabulary and comprehension and local assessments in writing (Holm & Holm, 1995; Rosier & Farella, 1976). Results of a program evaluation conducted in Hawaii indicated that a *culturally congruent* English language arts program significantly improved Native Hawaiian children's achievement in reading (Tharp, 1982). In the KEEP program, children engaged in activities and instruction that emphasized comprehension over mechanics and phonics and allowed children to interact and learn in ways that were congruent with their everyday experiences outside of school.

This report also summarized evidence on the effectiveness of mathematics curricula materials and instruction developed on the same principles of cultural congruence. In both an urban and rural setting, *ethnomathematics* led to improved student achievement for Native Hawaiian children and Alaskan rural middle school students (AKRSI, *Year Four Report,* n.d.a; Brenner, 1998).

In all cases — the Navajo tribally controlled schools, the Hawaiian KEEP lab schools, and the partner schools of the Alaska RSI — the development, implementation, and ongoing improvement of curricula programs, materials, and practices required collaborative relationships and time. Local community members, educators, university faculty, outside researchers or evaluators, and local, state, or BIA agency officials collaborated to identify Indigenous and everyday knowledge and create culturally congruent education programs and materials. Time across multiple years was needed to conduct this research and development work. Moreover, members of the networks and teams needed to know how to function in two linguistically and

culturally different worlds, apply for and manage outside funding from a variety of sources, and help teachers improve their practices through university course work, ethnographic research, and on-the-job mentoring and modeling.

Unquestionably, the generalizability of the evidence reviewed in this report is limited. It is limited by type of school and locale. In response to these limitations, the *American and Alaska Native Education Research Agenda* (U.S. Department of Education & U. S. Department of the Interior, 2001) calls for large-scale, multi-site research on the education experiences and outcomes of Native American students. A priority research topic is the level of Native American and Alaskan Native student achievement on standardized assessments by type of school and grade (U.S. Department of Education & U. S. Department of the Interior, 2001).[2]

Although limited in scope, the evidence synthesized is consistent with Demmert's (2001) conclusion that "congruency between the school environment and the language and culture of the community is critical to the success of formal learning" (p. 9). Our synthesis confirms the need to replicate the collaborative research and development efforts reported in the studies included in this review. In schools serving Native American students who are not meeting standards, the following action steps are recommended to improve student achievement:

1. Establish and support collaborative partnerships between community members, researchers, teacher education faculty, district- and school-level administrators, and teachers to create congruence between everyday, culturally specific knowledge from outside of school and the official content standards inside the school.

2. Use interviews, observations, and informal assessments to explicate and develop understanding of students' everyday and culturally specific knowledge, patterns of thought, and familiar ways of learning and social interaction.

3. Support teams of teachers and external partners with time and funding to (a) evaluate the cultural congruence of existing curriculum and materials and (b) develop and/or adapt curriculum and learning materials that incorporate everyday

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[2] Researchers and technical assistance providers at McREL are planning to contribute directly and indirectly to this agenda by conducting research on Native American student achievement in one or more of the seven Central Region states: Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming. An overview of our plan for this research is provided in Appendix A.

and culturally specific knowledge in ways that connect with content-area knowledge and skills.

4. Establish benchmarks for learning that mark progress toward increasingly more powerful and flexible reading comprehension, communication, and mathematical reasoning.

5. Develop or adopt multiple measures, including formal measures aligned with national content standards, to assess students' attainment of the benchmarks.

6. Establish observation protocols to document classroom implementation of the culturally congruent curriculum and materials.

7. Use the multiple measures and observation protocols to support field-testing, collection of evidence, and revision of culturally congruent curriculum and materials so that students' learning time is optimized and trivial matters are minimized.

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APPENDIX A

The consequences of standards-based reform for Native American students are unclear. Some observers contend that the reform's emphasis on stronger assessment and accountability systems has escalated pressures for standardization (Lomawaima & McCarty, 2002). From Lomawaima and McCarty's (2002) perspective, high-stakes testing devalues the knowledge that American Indian students bring to school and jeopardizes their "life opportunities by threatening to deny them a high school degree" (p. 298). Our review suggests that in order to achieve equity and excellence through standards-based reform, implementation of culturally congruent curricula and practices needs to become a higher priority than implementation of high-stakes testing. For the Alaska Rural Systemic Initiative, the development and implementation of culturally congruent curriculum and practices is top priority. The progress of this initiative and other standards-based reforms for American and Alaska Native children needs to be carefully observed. Fox (2000, p. 11) proposes that research on the implementation of standards for American and Alaska Native students be designed to answer such questions as:

- Were content and performance standards developed with the input of Indian people?
- Are Indian students receiving standards-based instruction?
- Are Indian students being assessed with multiple measures?
- Has Indian student achievement increased as a result of standards-based instruction?

McREL researchers and technical assistance providers plan to conduct collaborative research to address questions such as those posed by Fox (2000) and to strengthen the evidence base regarding effective practices for Native American student achievement. In some of the Central Region states, assessment results suggest that many Native American students are not meeting standards. In Kansas, on the fourth-grade reading test of the National Assessment of Education Program (NAEP), 22 percent of Native American students performed at or above proficient (National Center for Education Statistics [NCES], 1999b). In North Dakota, on the fourth-grade mathematics test, 42 percent of Native American students performed at or above proficient (NCES, 1999a). In a year 2000 survey, local educators in the Central Region identified effective instruction for students with diverse backgrounds as a critical issue for which their districts needed assistance. McREL is addressing this need.

Our research will be conducted according to procedures presented by Deyhle and Swisher (1997): (a) "formation of an advisory committee, (b) selection of trained Indigenous, bilingual

interviewers, (c) preparation of culturally sensitive instrumentation, and (d) consent from tribal officials representing target communities" (p. 179). Initially, the research will focus on gathering demographic data to document numbers and distributions of Native American students across the region by type of school, grade, locale, accountability system, and achievement. Next, the advisory committee will identify and select key research questions about the effectiveness of educational programs, supports, and practices for improving Native American student achievement. A research design will be developed and implemented in selected schools during the 2003–2004 academic year. It is expected that the process and findings will benefit Native American clients in the Central Region states.

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